

REMARKS

Favorable reconsideration and allowance of the subject application are respectfully requested. Claims 1-2 and 4-12 are pending in the present application, with claims 1 and 7 being independent. Claim 3 has been cancelled by this amendment without any prejudice to the subject matter contained therein.

Allowable Subject Matter

Applicant notes with appreciation the Examiner's indication on page 5 of the outstanding Office Action that claims 3-5, and 7-12 would be allowable if rewritten to overcome the rejections under 35 U.S.C. §112, second paragraph, and to include all of the limitations of the base claim and any intervening claims. At least for the reasons detailed below, Applicant respectfully submits that all pending claims should be considered allowable.

Drawings

The Examiner objected to the drawings under 37 CFR 1.83(a), stating that they fail to show a clear description of the elements as described in the specification. Applicant has amended the drawings, providing additional labeling. Accordingly, Applicant respectfully requests that the Examiner withdraw the objections.

Specification

The Examiner objected to the abstract and to the disclosure, alleging that the page preceding page 1 of the specification contains incorrect information regarding the instant application.

Applicant submits herewith a Substitute Specification, placing the application into proper form for U.S. patent practice. Applicant respectfully submits that no new subject matter has been added by this Substitute Specification. Accordingly, withdrawal of the objection is respectfully requested.

Claim Objections

The Examiner objected to claim 11 under 37 CFR 1.75(c) as being in improper form. The Examiner also objected to claims 1-12 because of minor informalities. Applicant has amended the claims in an effort to place the claims into proper form for U.S. patent practice. Accordingly, withdrawal of the objections is respectfully requested.

Claim Rejections Under 35 U.S.C. §112

The Examiner rejected claims 3-5, and 7-12 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter, which Applicant regards as the invention. This rejection is

respectfully traversed.

As stated above, Applicant has amended the claims, and has also addressed each of the objections identified by the Examiner. Accordingly, withdrawal of the rejection is respectfully requested.

Claim Rejections Under 35 U.S.C. §102

The Examiner rejected claims 1 and 2 under 35 U.S.C. §102(e) as being anticipated by *Kondo* (US 6,178,193). This rejection is respectfully traversed.

Applicant has amended independent claim 1 to include the features of canceled claim 3, which the Examiner indicated was allowable.

As such, Applicant respectfully submits that the cited art fails to teach or suggest the combination of elements as recited in claim 1, including at least that a power control command is set at the inverse of the measured amplitude if a fading duration is higher than a time duration between an amplitude or power measurement and the emission power setting and is set at the inverse of the average of the measured amplitude if the fading duration is equal to or lower than the time duration.

Accordingly, withdrawal of the rejection is respectfully requested.

Conclusion

In view of the above amendments and remarks, this application appears to be in condition for allowance and the Examiner is, therefore, requested to reexamine the application and pass the claims to issue.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Martin Geissler (Reg. 51,011) at telephone number (703) 205-8000, which is located in the Washington, DC area.

Pursuant to 37 C.F.R. §§ 1.17 and 1.136(a), Applicant(s) respectfully petition(s) for a one (1) month extension of time for filing a reply in connection with the present application, and the required fee of \$110.00 is attached hereto.

Application No. 09/579,893

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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MKM/MRG:tm/kss

Attachment: Substitute Specification
 Marked-Up Version Showing the Changes Made
 Replacement Drawing



MARKED-UP VERSION OF THE ORIGINAL SPECIFICATION

**METHOD FOR CONTROLLING THE EMISSION POWER OF A
TRANSCEIVER IN COMMUNICATION WITH ANOTHER TRANSCEIVER**

[0001] This nonprovisional application claims priority under 35 U.S.C. § 119(a) on Patent Application No. 99401272.2 filed in the United Kingdom on May 27, 1999, which is herein incorporated by reference.

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BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a method for use in controlling the emission power of a transceiver which is in communication with another transceiver, for use for example in a wireless communication system.

2. Description of the Background Art

[0003] Reference will now be made to Fig. 1 of the accompanying drawings which shows a transceiver 10 in communication with another transceiver 20 via a wireless communication system. Transceiver 10 is for example located in a base station and transceiver 20 in a mobile station. Data are exchanged between the transceiver 10 and the transceiver 20 via a wireless interface, a so-called radio channel. In Fig. 1, the transceiver 20 receives from the transceiver 10 a radio signal references as RC and sends to the transceiver 10 a radio signal with a power referenced as P. The same is for transceiver 10.

[0004] The characteristics of radio channels (for example: phase and amplitude) change continuously, due to variations in the geographical environment between a mobile station and a base station. These variations can be separated into free space propagation losses, slow fading and fast fading losses. Free space propagation losses depend on the path length between the transmitter and the receiver and can be modelled by a d^{-n} law where n is a number between 2 and 4 and d is the path length. Slow fading losses are due to shadowing occurring when obstacles, such as buildings, trees, etc., are

interposed between the transmitter and the receiver. Slow fading losses are known to generate variations in channel power for movements that are in the order of 10 times the wavelength of the radio signal. They can be modelled by a log normal law the standard deviation σ of which ranges between 4 and 12 dB depending on the kind of environment. Finally, fast fading losses are due to multipath effect in which a signal follows different paths and the resulting received signals recombine at the receiver entrance with different delays, amplitudes and phases. They can be modelled by a Rayleigh distribution. Movements that are in the order of 1/100 of the wavelength of the radio signal are sufficient to generate fast fading.

[0005] Most telecommunication systems use power control methods to limit interference and power consumption. Power control methods aim to command an emission power of both transceivers as close as possible to the minimum needed for a defined quality of transmission.

[0006] Such a method includes, carrying out in an evaluating unit 200 of a transceiver (here the transceiver 20), the steps of measuring the received power of the radio signal RC (or its amplitude) and, on basis of the result of this measurement, of evaluating a power control command PC . The power control command PC is used to command a transmission unit 210 so that it transmits signals with a power P corresponding to the command PC .

[0007] Note that the transceiver 10 comprises also such an evaluating unit and a transmission unit.

[0008] Due to the time duration (referenced as t_d in the following description) between the moment of the input amplitude measurement (made in the evaluating unit 200) and the moment of the use of the control command signal PC to command the emission power P (made in the transmission unit 210), the power control methods are based on a measurement and an evaluation which are made during reception and which are used to determine the power to be transmitted during the next emission.

[0009] The value of the time duration t_d is imposed by the system for given periods and thus is known by the considered transceiver.

[0010] The emission power P is applied with a certain delay t_d after the

measurement has been made by the evaluating unit 200; hence the channel features can have significantly changed between the evaluation and the application of the *PC* command. The power control command *PC* then wrongly compensates the channel variations, particularly in the case of fast fading losses, where the stronger the fading is, the quicker it disappears.

SUMMARY OF THE INVENTION

[0011] ~~The object of the present invention is~~ It is therefore an object of the present invention to overcome the above-mentioned problem and then to propose a method for adaptive power control, which can be used in communication systems wherein the power control delay is longer than the time needed for significant variations in channel features to occur.

[0012] To this end, a method for controlling the emission power of a transceiver in communication with another transceiver of a communication system according to the present invention includes the steps of evaluating the fast fading duration and of deducing the power control command from the fast fading duration on basis of the amplitude or the power measurement made by the receiver.

[0013] According to another feature of the invention, the method includes, for deducing the power control command, the step of comparing the evaluated fast fading duration with the time duration between the amplitude or the power measurement and the emission power setting, and according to the result of the comparison, in determining said the power control command.

[0014] According to another feature of the invention, the method includes the step of setting the control command signal *PC* at the inverse of the measured amplitude $1/L_m$ if the fast fading duration t_f is higher than the time duration t_d between the amplitude or power measurement and the emission power setting and at the inverse of the short-term average of the measured amplitude $1/L_{av}$ if it is equal to or lower than said time duration

- i. $1/L_m$ if $t_f > t_d$
 $1/L_{av}$ if $t_f \leq t_d$

~~The aforementioned feature of the invention, as well as others, shall become clearer on reading the following description on an embodiment, said description~~

being made with reference to the attached drawings, in which:

[0015] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

[0017] Fig. 1 is a schematic diagram illustrating a communication system provided with a power control system[[.]];

[0018] Fig. 2 is a block schematic diagram of an evaluating unit of a transceiver in a communication system provided for carrying a method according to the inventions[[.]]; and

[0019] Fig. 3 is a graphic illustrating the received amplitude with time for use in explaining the method according the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The method of the invention is applied to a communication system such as the system represented in Fig. 1 and is carried out in the evaluating unit of each transceiver 10, 20 of the communication system. Only, the evaluating unit 200 of the transceiver 20 is now considered.

[0021] The evaluating unit 200 depicted in more detail in Fig. 2 has a measurement unit 21 for measuring at predetermined times t the amplitude L_m of the received signal RC , a averaging unit 22 for determining the short-term average L_{av} of the measured amplitude L_m , an estimation unit 23 for estimating the fading duration t_f and a control unit 24 for determining the power control

command signal PC which is provided for use by a transmission unit 210 to set the emission power P at the value given by the PC command.

[0022] Fig. 3 shows the variations with time of the received amplitude L at the receiver 20 input. Downward arrows indicate measurement times made by the evaluating unit 200 and upward arrows indicate the emission times made by the transmission unit 210. At measurement times, the received amplitude is the measured amplitude and is noted L_m . The dotted line represents the short-term average of the measured amplitude L_m that is then noted as L_{av} . The received amplitude L is representative of the free space fading, of the shadowing fading and of the fast fading. The short time average amplitude L_{av} is representative of only the free space fading and the shadowing fading.

[0023] Note that the short-term amplitude L_{av} is defined as being the average of the measured amplitude L_m over time periods corresponding to the variation time of the slow fading essentially due to shadowing.

[0024] The fading duration t_f is defined as being the average time for which the received amplitude L will stay below the measured amplitude L_m if said measured amplitude L_m is lower than the short-term average amplitude L_{av} or above the measured amplitude L_m if said measured amplitude L_m is higher than the short-term average amplitude L_{av} .

[0025] In order to optimise the confidence level of the power control, the method according to the invention determines the power control command signal regarding the estimated fading duration t_f derived from the fading depth L/L_{av} . In other words, the power control command value $PC(t_d)$ is equal to the inverse of measured amplitude if the fading duration t_f is longer than the delay t_d between the moment of the amplitude measure made by the evaluating unit 200 and the application of the power control command $PC(t_d)$ to the transmission unit 210 and is equal to the inverse of the average amplitude L_{av} if it is shorter:

$$\begin{aligned} & i. \quad 1/L_m \text{ if } t_f > t_d \\ & \quad 1/L_{av} \text{ if } t_f \leq t_d \end{aligned}$$

[0026] Note that the power control command value $PC(t_d)$ is the value which will be used by the transceiver 20 at the present time + t_d to set the emission power P at the evaluated value $PC(t_d)$.

[0027] In Fig. 3, at time t_1 , the fading time t_f is shorter than the time duration t_d . Hence, the power control command $PC(t_d)$ is the inverse of the short term average amplitude $1/L_{av}$. It is the same for the time t_3 . At time t_2 , the fading time t_f is higher than the time duration t_d . Hence the power control command $PC(t_d)$ is the inverse of the measured amplitude $1/L_m$. It is the same for time t_4 .

[0028] Note that the fading duration is too short to impact upon the emission for cases t_1 and t_3 but it is long enough to do so for cases t_2 and t_4 .

[0029] The method of the invention give an adaptive amplitude correction able to balance fast fading as well as shadowing and free space losses, since the short-term amplitude average L_{av} correct shadowing and free space channel variations.

[0030] Note that the estimation unit 23 needs the value of the speed v of the transceiver 20 relative to the transceiver 10 to evaluate the fading duration t_f . A dedicated unit (not shown) can determine or evaluate and deliver this value.

[0031] From a publication of Gans in IEEE Trans. Veh. Technol., Vol. VT21, February 1997 1972, pp.27-38, the fast fading duration can be estimated in the following way:

$$t_f = \begin{cases} (a) \frac{\lambda}{\sqrt{2\pi L}v} [e^{(\bar{L})} - 1] & \text{if } \bar{L} \leq 1 \\ (b) \frac{\lambda}{\sqrt{2\pi L}v} & \text{if } \bar{L} > 1 \end{cases}$$

where \bar{L} is the measured amplitude L_m at a measurement time normalised by the short-term average amplitude L_{av} ($\bar{L} = L_m/L_{av}$), v and λ are respectively the speed of one transceiver 10 relative to the other 20 and the wavelength of the carrier used by the communication system.

[0032] The power control command $PC(t_d)$ can be now given by the following scheme:

$$a. \quad PC(t_d) = \begin{cases} 1/L_m & \begin{cases} \text{if } \bar{L} < 1 \text{ and } t_d < \frac{\lambda}{\sqrt{2\pi} L v} [e^{(\bar{L}^2)} - 1] \\ \text{if } \bar{L} \geq 1 \text{ and } t_d < \frac{\lambda}{\sqrt{2\pi} L v} \end{cases} \\ 1/L_{av} & \begin{cases} \text{if } \bar{L} < 1 \text{ and } t_d \geq \frac{\lambda}{\sqrt{2\pi} L v} [e^{(\bar{L}^2)} - 1] \\ \text{if } \bar{L} \geq 1 \text{ and } t_d \geq \frac{\lambda}{\sqrt{2\pi} L v} \end{cases} \end{cases}$$

where $PC(t_d)$ is the power control command which will be used at the present time (assumed to be zero) + t_d , L is the received amplitude, L_{av} is the short-term average of the measured amplitude, t_d is the time delay between the moment of the measurement of the received amplitude L_m and the use of the PC command and $\bar{L} = \frac{L_m}{L_{av}}$ is the normalised received amplitude.

[0033] A simplified equation can easily be derived:

$$PC(t_d) = \begin{cases} 1/L_m & \text{if } t_d < \frac{\lambda * \min(\bar{L}, \frac{1}{\bar{L}})}{\sqrt{2\pi} v} \\ 1/L_{av} & \text{if } t_d \geq \frac{\lambda * \min(\bar{L}, \frac{1}{\bar{L}})}{\sqrt{2\pi} v} \end{cases}$$

[0034] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are to be included within the scope of the following claims.

CLAIMS

What is claimed is:

ABSTRACT

The present invention relates to a method for use in controlling the emission power of a transceiver (20) which is in communication with another transceiver (10) via a communication system, said method including the steps of measuring the amplitude or the power of the signal received by said transceiver (20) and of evaluating a power control command (PC) which is then used to command the emission power (P) of said transceiver according to said control command signal (PC).

According to the invention, the method includes the steps of evaluating the fast fading duration of the received signal on basis of said amplitude or power measurement and of deducing the power control command (PC) from said fast fading duration.